Marine Corps Air Station Miramar
Installation Microgrid
P-906

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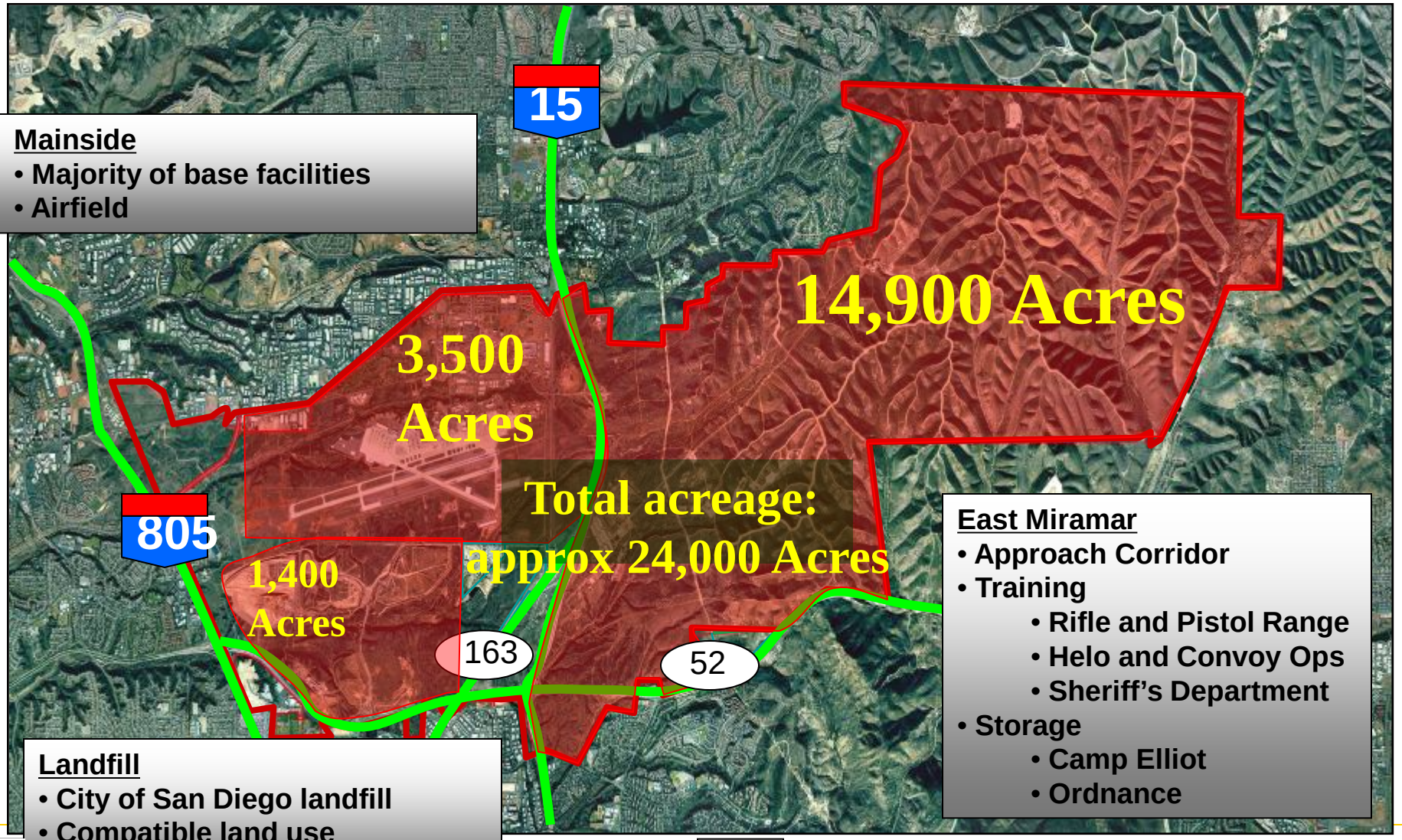
MCAS Miramar Mission

Our mission is to maintain and operate the facilities and provide services and material to support the operations of 3d Marine Aircraft Wing and other tenant organizations.

MCAS Miramar Overview



Mainside
- Majority of base facilities
- Airfield

East Miramar
- Approach Corridor
- Training
  - Rifle and Pistol Range
  - Helo and Convoy Ops
  - Sheriff's Department
- Storage
  - Camp Elliot
  - Ordnance

Landfill
- City of San Diego landfill
- Compatible land use
- Unimpeded airspace

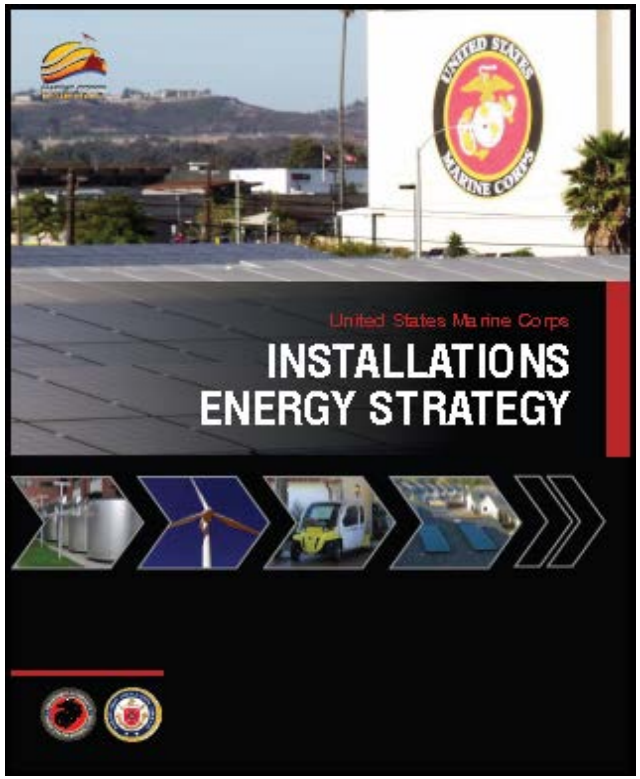
MCAS Miramar 101

- Miramar has been a Navy or Marine Corps Air Station since 1940
- On average there are 200 aircraft assigned to Miramar
  - Roughly 100 Fixed Wing and 100 Rotor Wing and Tilt Rotor
- Approximately 9,300 Marines and Sailors are assigned to Miramar
  - 1,800 or 20% are deployed at any given time
- Approximately 1,700 civilians work on Miramar
- 900 or 10% of Miramar's Marines are female
- Approximately 17,000 dependents of Miramar service members attend schools in San Diego

Home to 3d Marine Aircraft Wing

Air Station Ground Training

Energy Strategy



Lines of Operation

Energy Information

Provide clear feedback to all energy users and emphasize user-controlled reductions.

Energy Efficiency

Invest USMC resources to improve facilities energy efficiency and cut energy intensity.

Renewable Energy

Pursue third-party financing for cost-effective renewable energy resources.

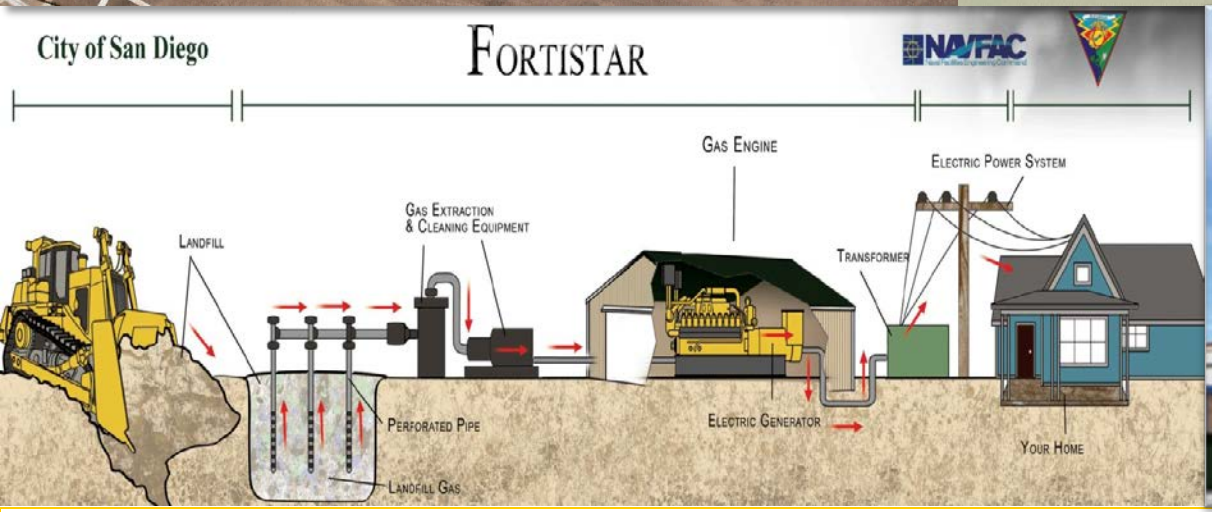
Energy Security

Upgrade and integrate energy infrastructure to improve security and mitigate risk.

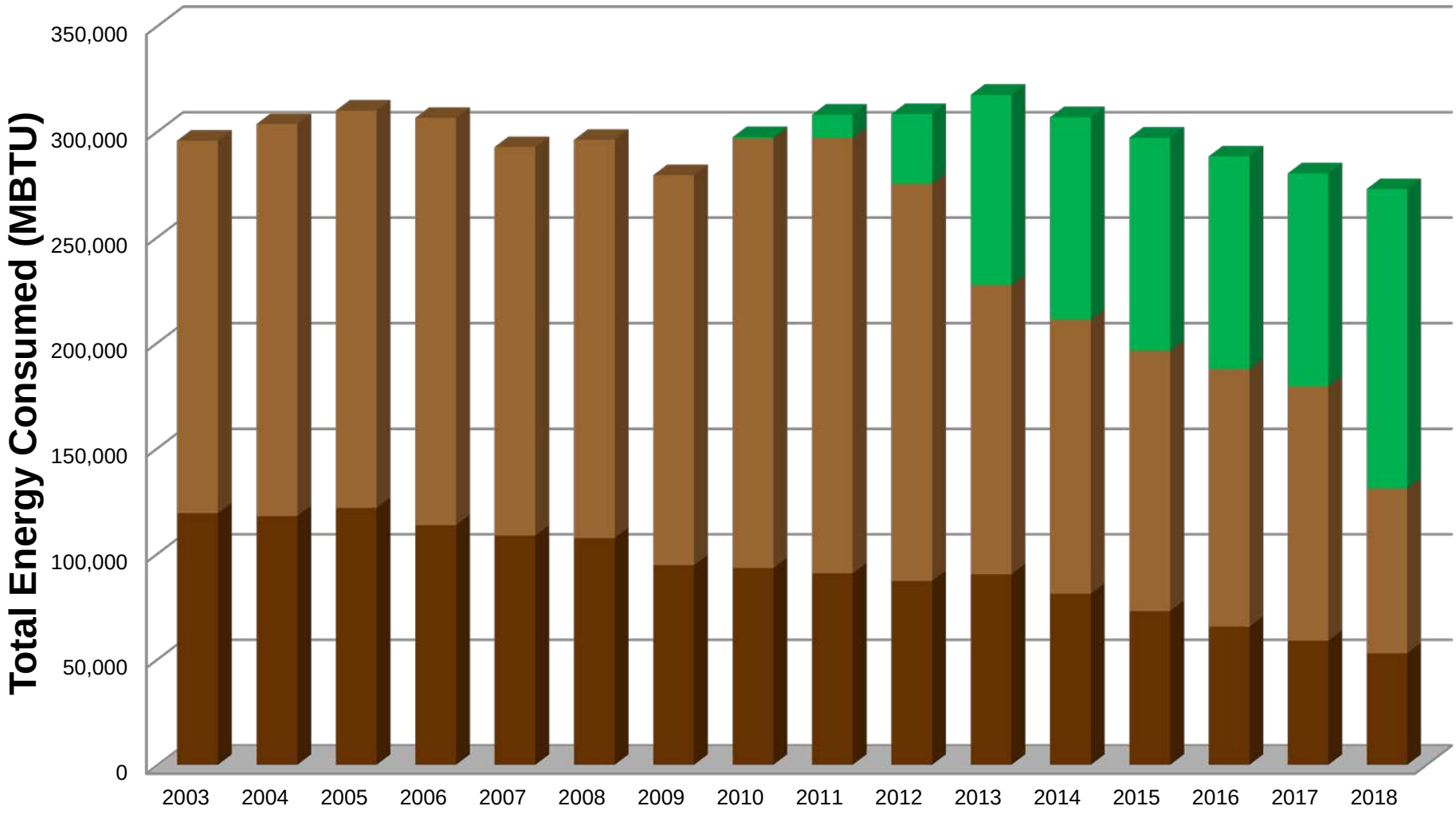
Energy Ethos

Recognize energy as a strategic resource by All Hands, 24/7/365, from Bases to Battlefield

Renewable Energy



Renewables

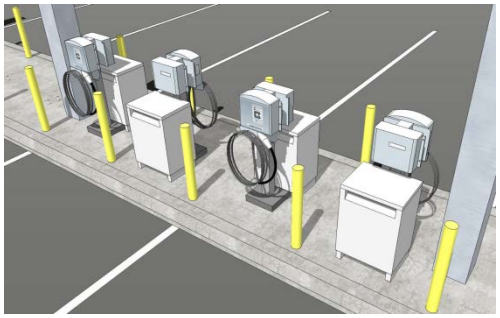

Total Energy Consumed (MBTU)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

Electric Vehicles

Navy Regional Roll Out – Phase 1

- 34 Vehicles arriving December 2016
- 12 EVSE “charging stations” at 4 locations
- Cost = $427

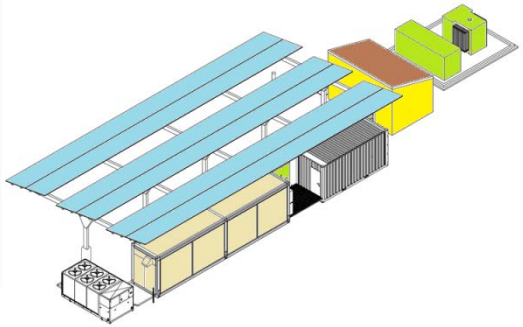
- **Options funded by MCI West**
  - Load Control Scheme for “microgrid ready”
  - Provisions for expansion or private use
  - Advanced Metering
  - Bi-Directional Chargers (V2G Project Infrastructure)
  - Total = $398K

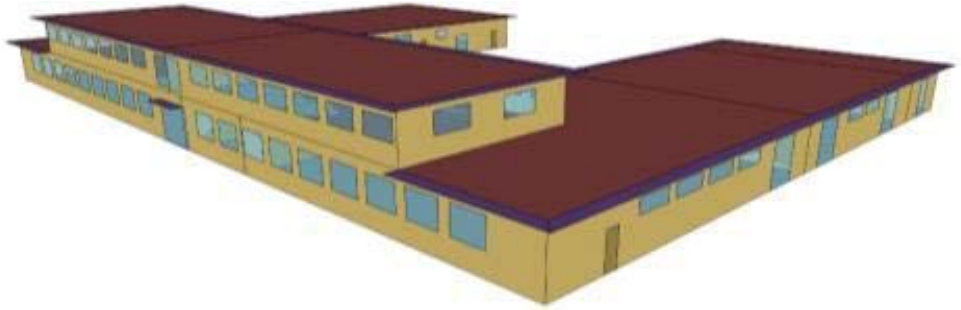


Vehicle to Grid Demonstration

- 6 electric vans, bi-directional charging stations, and research
- Funded by California Energy Commission (CEC) grant
- Within Installation Microgrid Island

Microgrids at Miramar





Installation Level Microgrid

- Energy Security Microgrid for Critical Facilities
- FY2014 ECIP Project
- Awarded in May for $20M
- Projected Completion Nov 2018

Building Level Microgrid

- Zinc Bromide Flow Battery Installation for Islanding and Backup Power
- FY2012 ESTCP Project
- Cost ~$3M
- Demonstrated June 2016

Partners

Installation Microgrid P-906

Schneider Electric

&

BLACK & VEATCH
A Joint Venture

GENERAL DYNAMICS
Information Technology

LARCO DEVELOPMENT INC

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Building Level Microgrid with Energy Storage

ESTCP

Raytheon

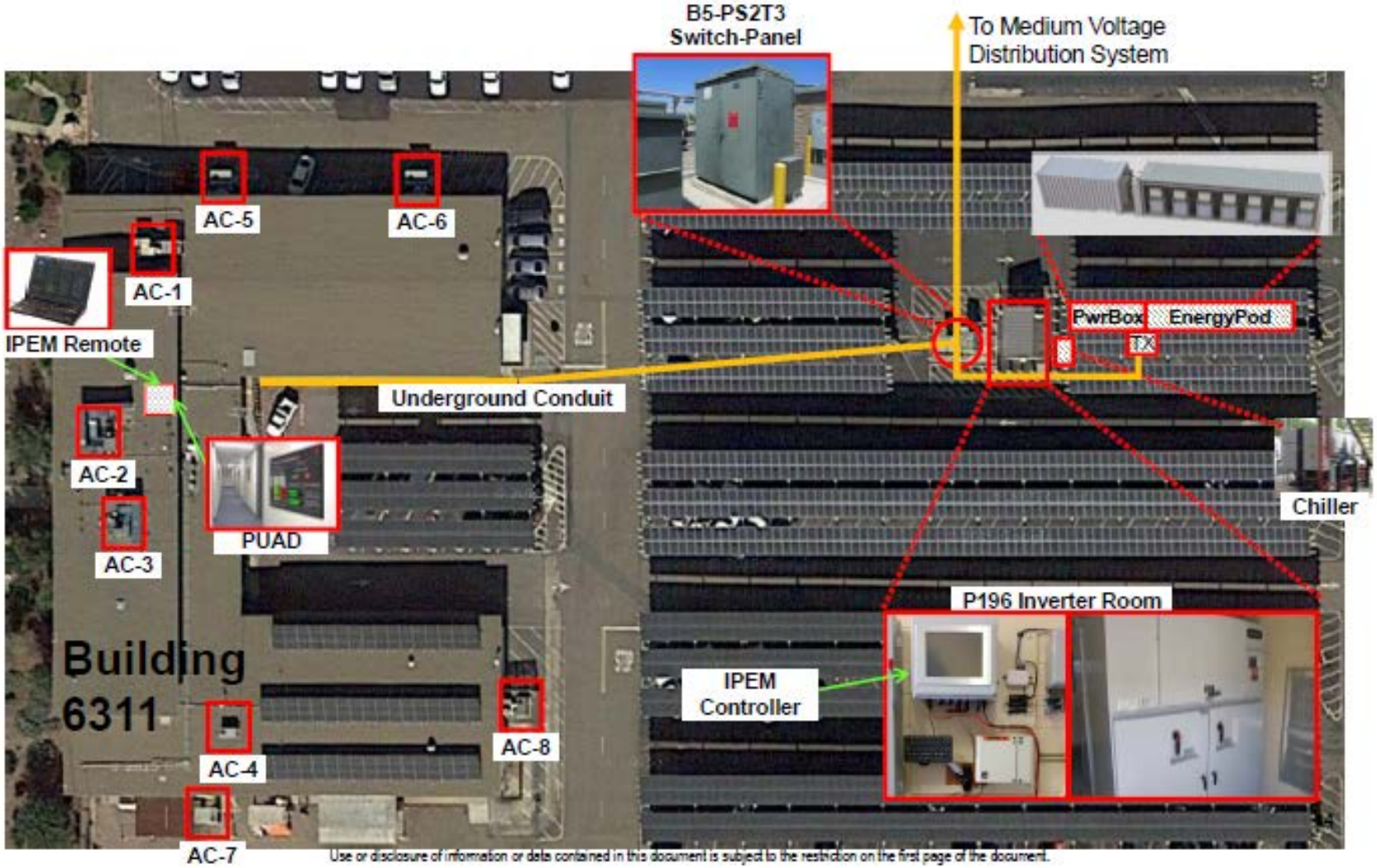
PRIMUS POWER

Dynalectric

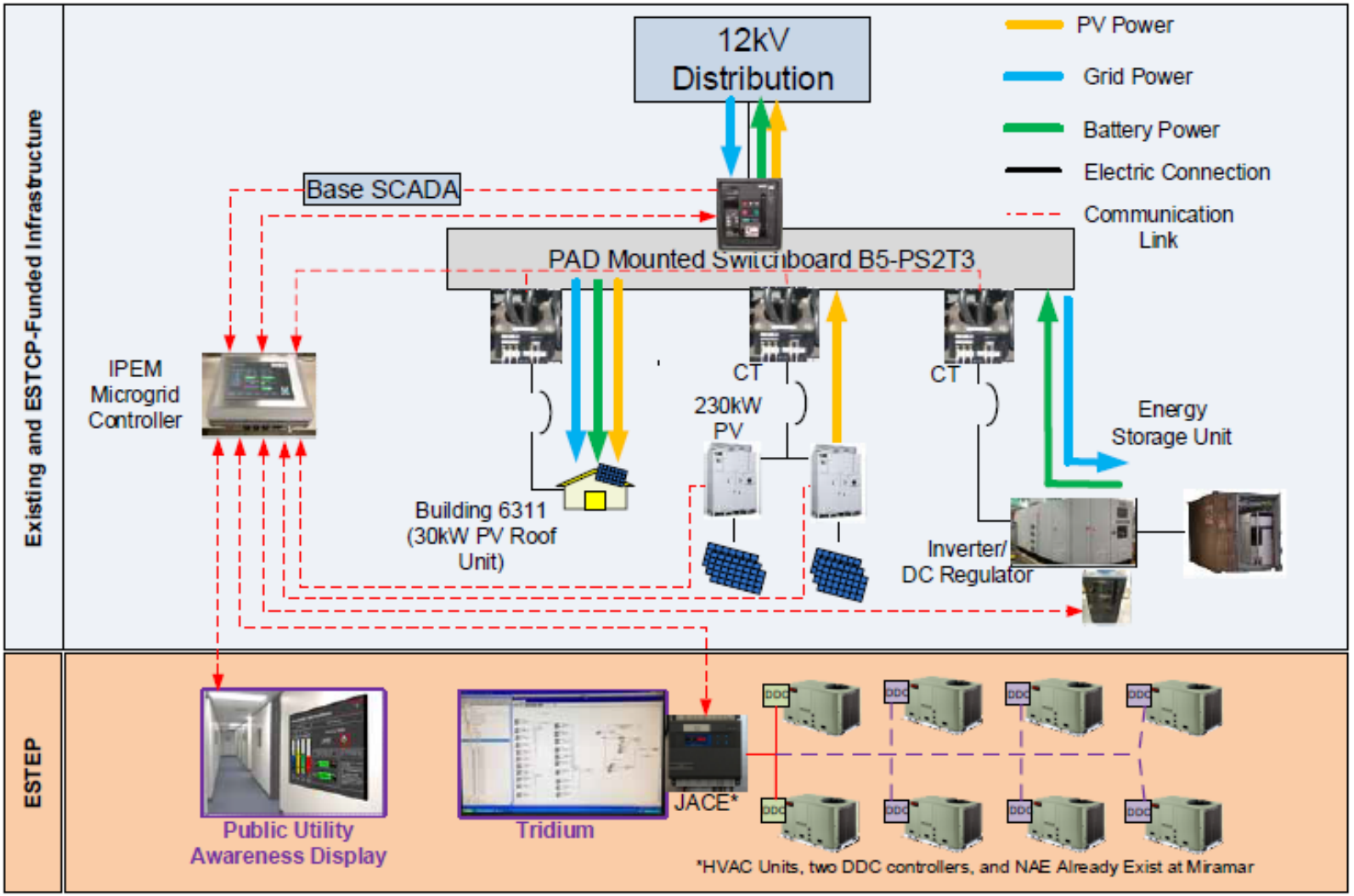
ADVANCED ENERGY

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Building Level Microgrid Overview



System Integration



National Renewable Energy Lab

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

http://youtu.be/XriDpR14C-k

Unique Capabilites

Hardware-in-the-Loop at Megawatt-scale Power

Megawatt-scale power-in-the-loop allows researchers and manufacturers to conduct integration tests at full power and actual load levels in real-time simulation and evaluate component and system performance before going to market.

High Performance Computing Data Center (HPCDC)

Petascale computing at the HPCDC enables unprecedented large-scale modeling and simulation of material properties, processes, and fully integrated systems that would otherwise be too expensive, too dangerous, or even impossible to study by direct experimentation.

Research Electrical Distribution Bus (REDB)

The ultimate power integration circuit, made up of two AC and two DC ring buses, connects multiple sources of energy and interconnects "plug-and-play" testing components in all the labs.

Supervisory Control and Data Acquisition (SCADA) Systems

The SCADA system monitors and controls REDB operations and safety and gathers real-time, high-resolution data for collaboration and visualization.

Data Analysis and Visualization

Analysis and visualization capabilities at the ESIF go beyond what is found in a typical utility operations center. Fully integrated with hardware-in-the-loop at power capabilities, an electrical distribution bus, a SCADA system, and petascale computing, the ESIF allows researchers and NREL partners to visualize complex systems simulations and operations in a completely virtual environment.

Energy Systems Integration Facility

NREL | ENERGY SYSTEMS INTEGRATION FACILITY
NATIONAL RENEWABLE ENERGY LABORATORY

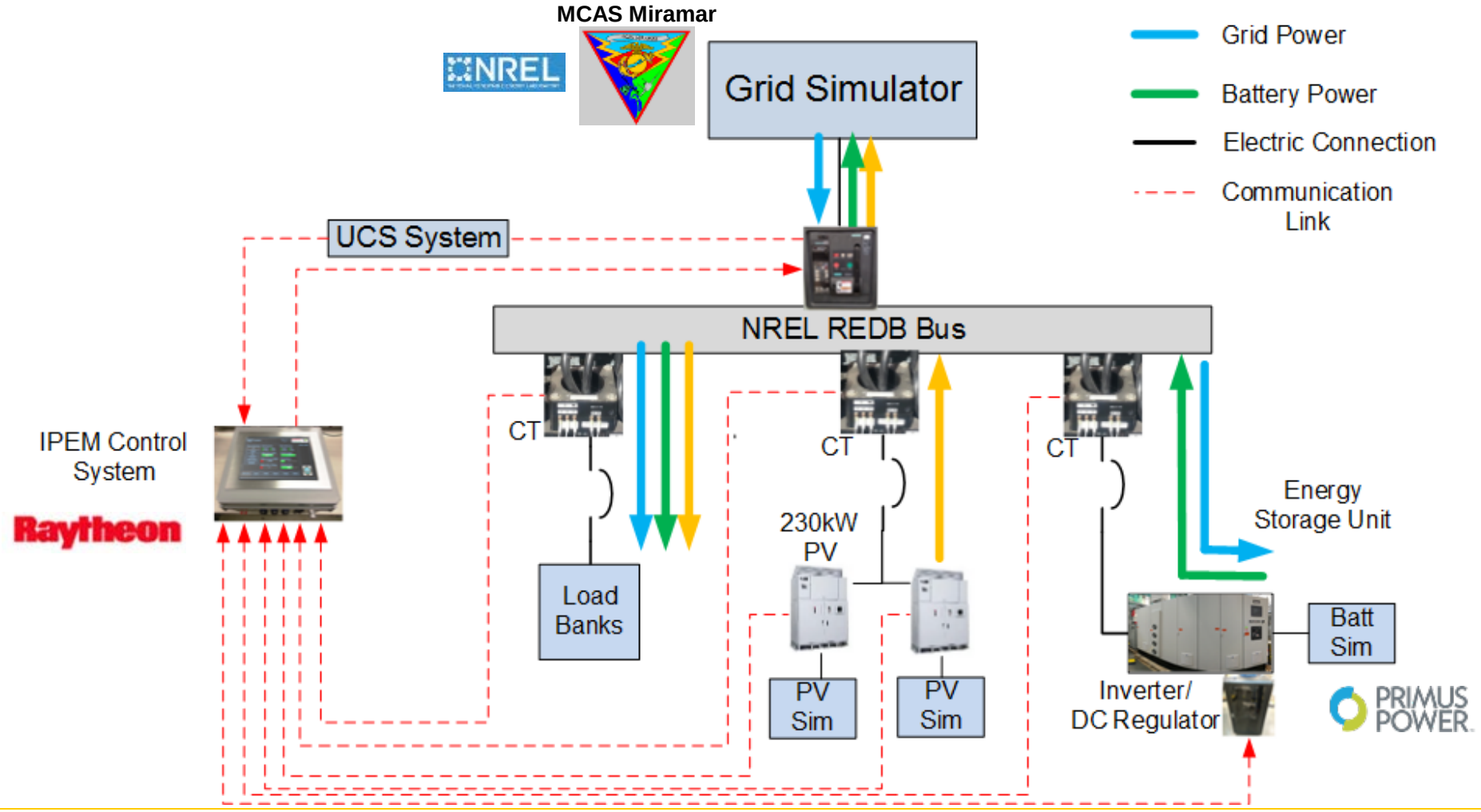
U.S. DEPARTMENT OF ENERGY

The **Energy Systems Integration Facility (ESIF)** is a unique new national asset for energy systems integration research, development, testing, and analysis. Located on the U.S. Department of Energy's National Renewable Energy Laboratory campus in Golden, Colorado, the 182,500 sq. ft. facility contains approximately 200 office and collaboration spaces, state-of-the-art laboratories, and several outdoor test areas.

Uniquely equipped with megawatt-scale test capabilities; integrated electrical, thermal and fuel infrastructures; advanced data analysis and visualization capabilities; hardware-in-the-loop simulation; and a high performance computing data center, the ESIF stands in a class of its own.

1. Power Systems Integration
2. Smart Power
3. Energy Storage
4. Electrical Characterization
5. Energy Systems Integration
6. Thermal Storage Process and Components
7. Thermal Storage Materials
8. Optical Characterization and Thermal Systems
9. Energy Systems Fabrication
10. Manufacturing
11. Materials Characterization
12. Electrochemical Characterization
13. Energy Systems Sensor
14. Fuel Cell Development and Test
15. Energy Systems High Pressure Test
16. ESIF Control Room
17. Energy Integration Visualization Room
18. Secure Data Center
19. High Performance Computing Data Center
20. Insight Center Visualization Room
21. Insight Center Collaboration Room

NREL Test Setup Interconnect

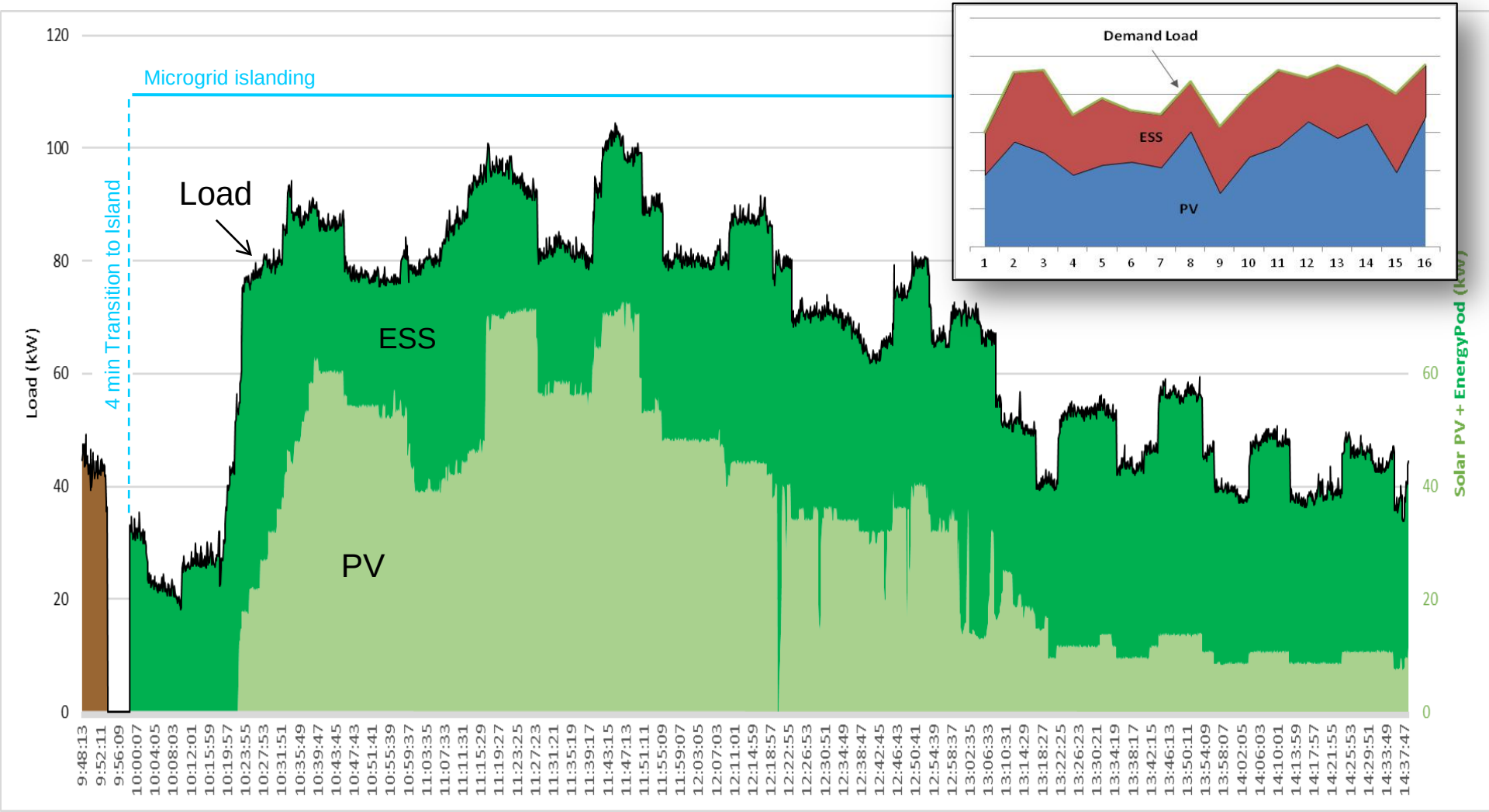


Live Testing at NREL

Delivery Pictures

MCAS Miramar Demonstration

Island Results



Energy Resilience

THE SAN DIEGO U-T UNION-TRIBUNE

FRIDAY SEPTEMBER 9, 2011 92¢

- **Massive outage:** 1.4 million SDG&E customers powerless
- **The cause:** Failure in Arizona triggered cascade of events
- **No school:** All county public schools are closed today
- **Water worries:** City issues boil-water order in some areas
- **What's next:** Power to be restored in waves into Saturday

BLACKOUT

OUTAGE CALLED 'UNPRECEDENTED'

2 MAIN LINKS TO REGION ARE CUT

P-906 Installation Microgrid Overview

Project Details

- **Energy Security Microgrid for Critical Facilities**
- **FY2014 ECIP Project**
- **Programmed Cost $18M**
- **Awarded in May 2016 for $20M**
- **Projected Completion Nov 2018**

Project Description

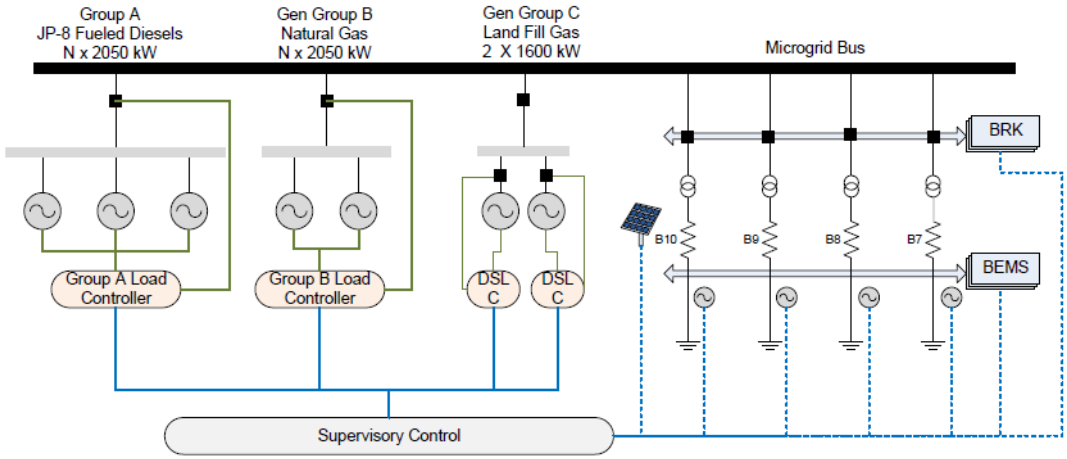
- Install diesel (4 MW) and natural gas (3 MW) generation with the ability to power 100% of the flight line and support facilities (100+ facilities = 4 – 7 MW)
- Incorporate existing onsite landfill power generation (3.2 MW) and existing PV generation (1.3 MW) into microgrid islanding as much as feasible.
- Enable generation to participate in demand response during grid connection.
- Build Energy Operations Center
- Cyber Security accreditation through Risk Management Framework

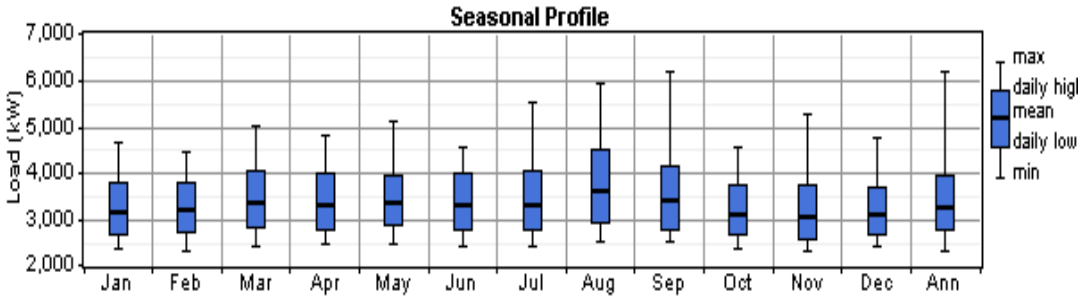
Project Goals

1) Energy Security (Back-up Power)
2) Renewable Integration
3) Revenue/Grid Support

NREL

- **NREL complete Net Zero Energy Installation Assessment in 2010**
- **NREL CORE microgrid assessment completed in 2012**
  - Critical load analysis
  - Generation option analysis
  - Electrical systems modeling
  - Financial analysis
  - ECIP application (DD1391)
- **P-906 Authority to Design given in August 2013**
  - RFP development (NAVFAC SW)
  - NREL contracted for consultation
- **Post award "owner's engineer" Services awarded in October 2016**
  - ✓ Design Support
  - ✓ Quality Control
  - ✓ True Third Party
  - ✓ Commissioning *Authority*
  - ✓ Report Generation
  - ✓ Economic Analysis





P-906 Microgrid

Existing Assets

3.2 MW Landfill Gas Energy Plant

Regional SCADA System

80 Bldg. Central DDC System

1 MW PV Carports

356 kW Thin-Film PV Roof Systems

230 AMI Meters

Smart Microgrid

New Construction

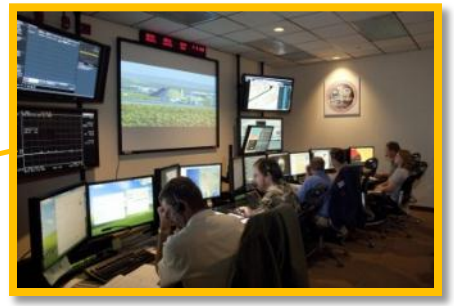
Diesel and Natural Gas Power Plant

Energy Operations Center

P-906 Microgrid Map

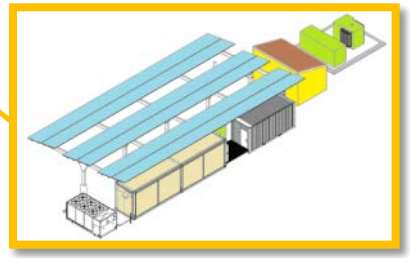
Microgrid Backup Power Plant

- 4 MW Diesel Generator Set
- 3 MW Natural Gas Generator Set
- Central Microgrid Controller
- Energy Storage



Energy Operations Center

356 kW Thin-Film PV Roof Systems



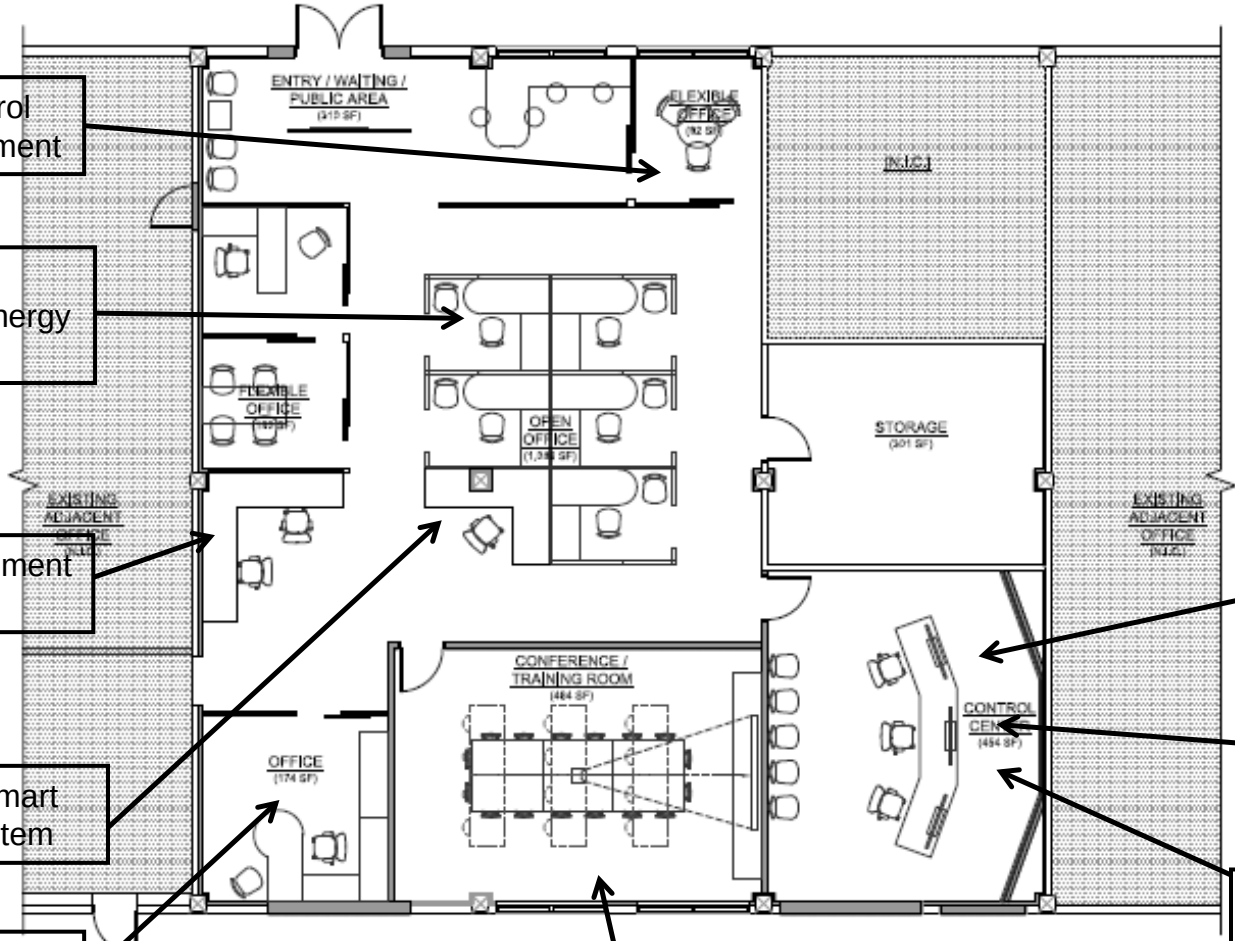
250 KW / 1 MWH Battery Storage

3.2 MW Landfill Gas Energy Plant

435 kW PV Carports

511 kW PV Carports

P-906 Microgrid Operations Center



Industrial Control System Management

Project Development/Energy Auditing

Technology/Equipment Testing

"Calsense" Smart Irrigation System

Installation Energy Management

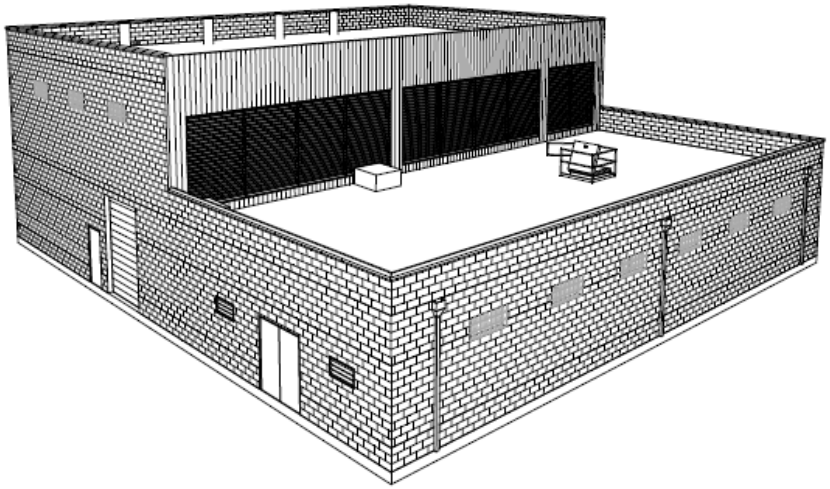
Tenant Training/Behavioral Awareness/Outreach

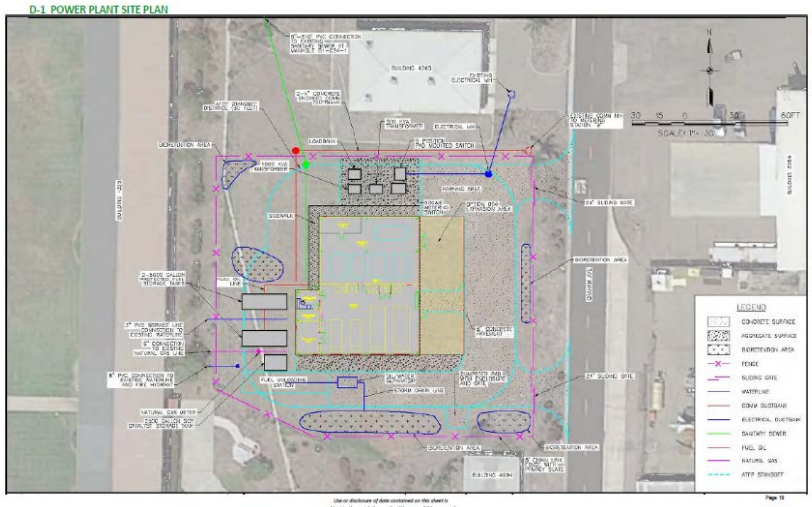
Advanced Metering Infrastructure

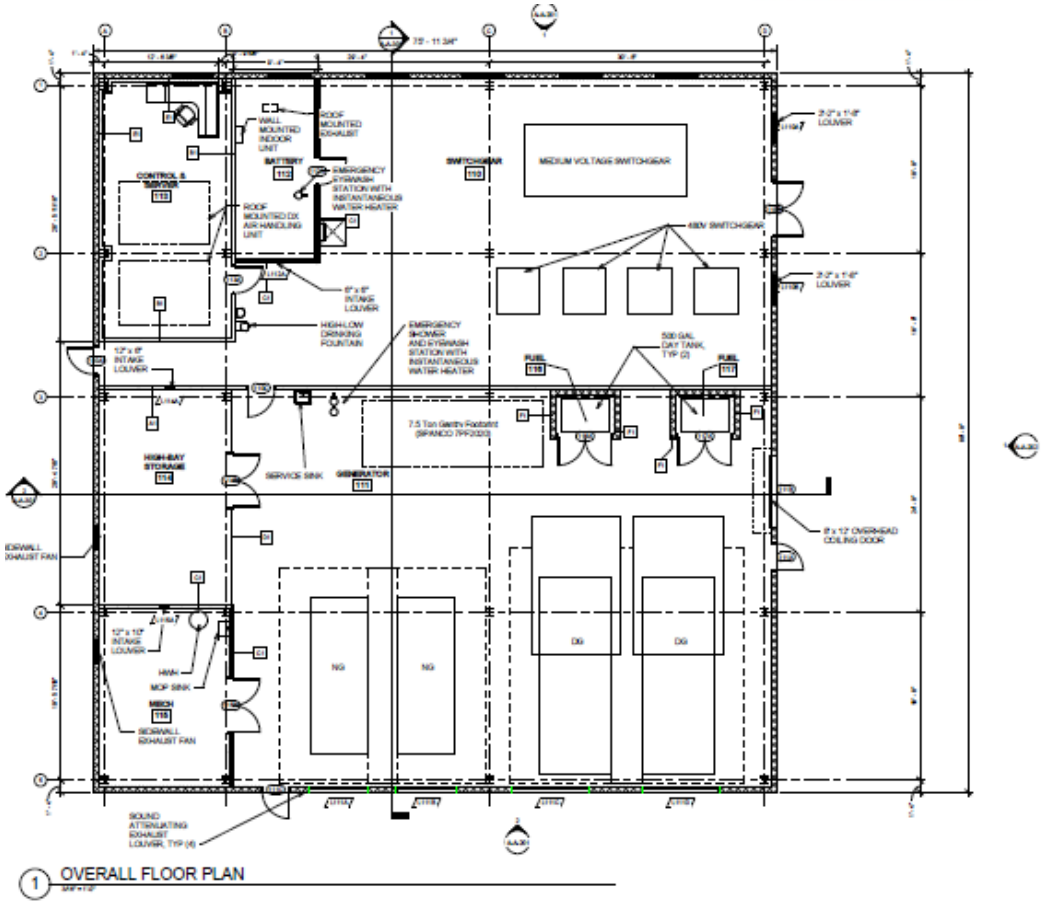
Area Wide Energy Management System (HVAC Controls)

Installation Microgrid Controller & SCADA Station

P-906 Power Plant





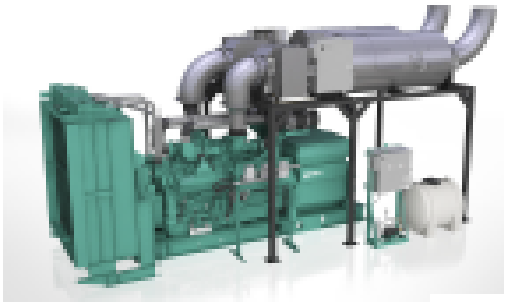


P-906 Power Plant

Cummins **Power Generation**

Tier4 certified diesel generator set QSK60 series engine

1450 kW - 2250 kW 60 Hz



U.S. EPA

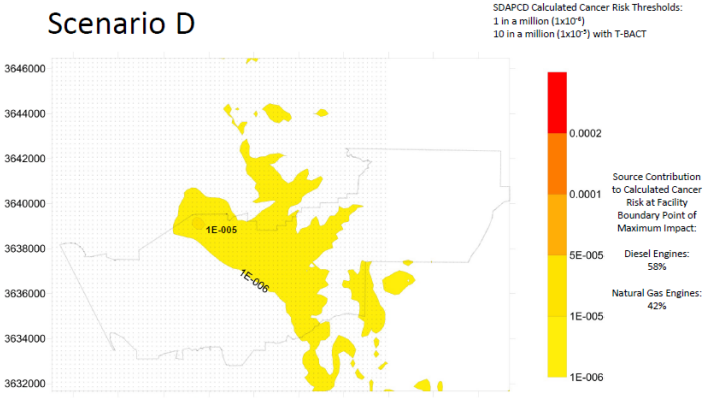
Engine certified to US EPA Nonroad 40CFR1039 and Stationary (Emergency and Non-Emergency) US EPA NSPS, 60CFR Subpart IIII Tier4 Emissions Standards.

Natural gas generator set QSK60 series engine

> Specification sheet
1160 kW - 1400 kW

Exhaust emissions – Lean burn technology provides exhaust emissions levels as low as 350 mg/Nm^3 (0.7 g/hp-hr) NO_x.

Scenario D



	Scenario	Operating Characteristics						
		Fuel Type	Total No. of Engines	Hours/Year (ea) M/T	Hours/Year (ea) Prime Use	Maximum Hours/Day	No. engines operating simultaneously	DPF/SCR?
Scenario D	All Prime Operation Tier 4 Final Diesel Engines • Limited Hours – 1,500 hrs. Natural Gas Engines • Limited Hours – 8,760 hrs. Tier 4 Final Diesel Engines Meet BACT and Natural Gas with BACT.	Diesel	4	0	1,500	24	4	No
		Natural Gas	2	0	8,760	24	2	Yes
		Total	6	0	23,520	144	N/A	

P-906 Concept of Operations

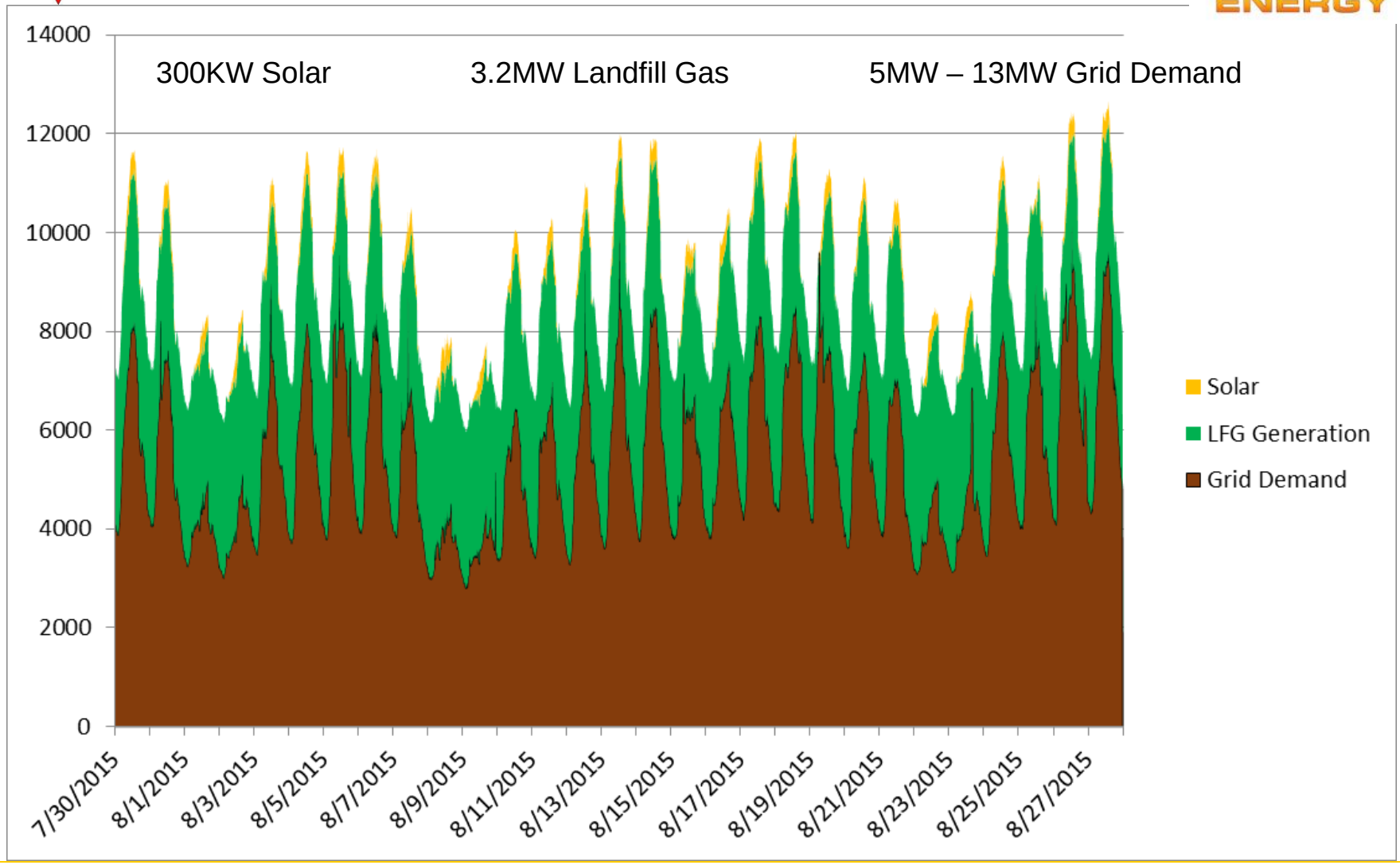
MCAS Miramar P906 Microgrid Grid Connected Mode Theory of Operations	Summer (May 1 -October 31)				
	Weekdays (Mon-Fri)				Weekends & Holidays
	Semi-Peak 6am - 11am	Peak 11am - 6pm	Semi-Peak 6pm - 10pm	Off-Peak 10pm - 6am	Off-Peak All hours
1400 kW NG Genset	Operate to offset utility purchase. Modulate output as required to maintain *operator* defined minimum utility import.			Off	Off
1400 kW NG Genset				Off	Off
1825 kW Diesel Genset	Operate in response to failure of a single landfill gas generator			Off	Off
1825 kW Diesel Genset	Off	Operate as required for purposes of peak shaving and/or demand response. Demand response level determined by *operator* via collaboration with electric utility	Off	Off	Off

Prime Permitted Operating Hours

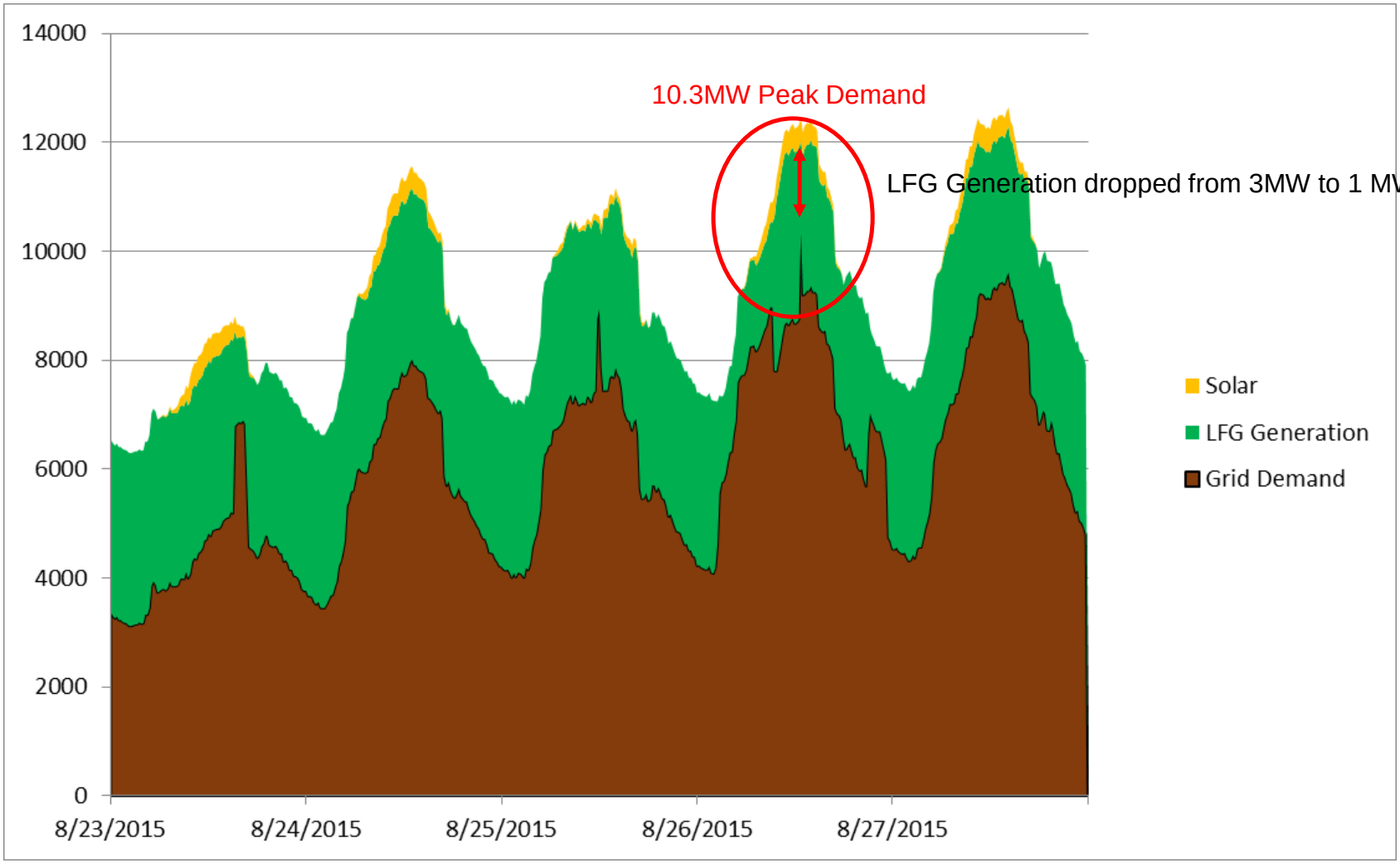
- Tier 4 Certified Diesel = 1500 Hours/Year
- BACT Natural Gas = 5000 Hours/Year

Opportunity	Approach Summary	Potential Annual Savings
Base load Energy Cost Reduction	Operate new natural gas-fired generators for approximately 2800 hours / year to reduce base load energy (i.e. kWh) charges during the utility rate structure's peak and semi peak time periods.	$150,000 - $200,000
Base load Demand Cost Reduction	Avoided Demand charges due to operation of the natural gas-fired generators during peak and semi-peak periods.	$150,000 - $200,000
Demand Cost Reduction – Respond to landfill-gas or natural gas fueled generator(s) failure	Operate new diesel-fired generators to replace the output of MCAS Miramar generation assets that fail during semi-peak and off-peak hours	$400,000 - $500,000
Demand Cost Reduction – Peak shaving	Operate natural gas and diesel-fired generators to shave peak demand during the utility rate structure's peak and semi-peak time periods	$400,000 - $450,000

MCAS Miramar Load Profile

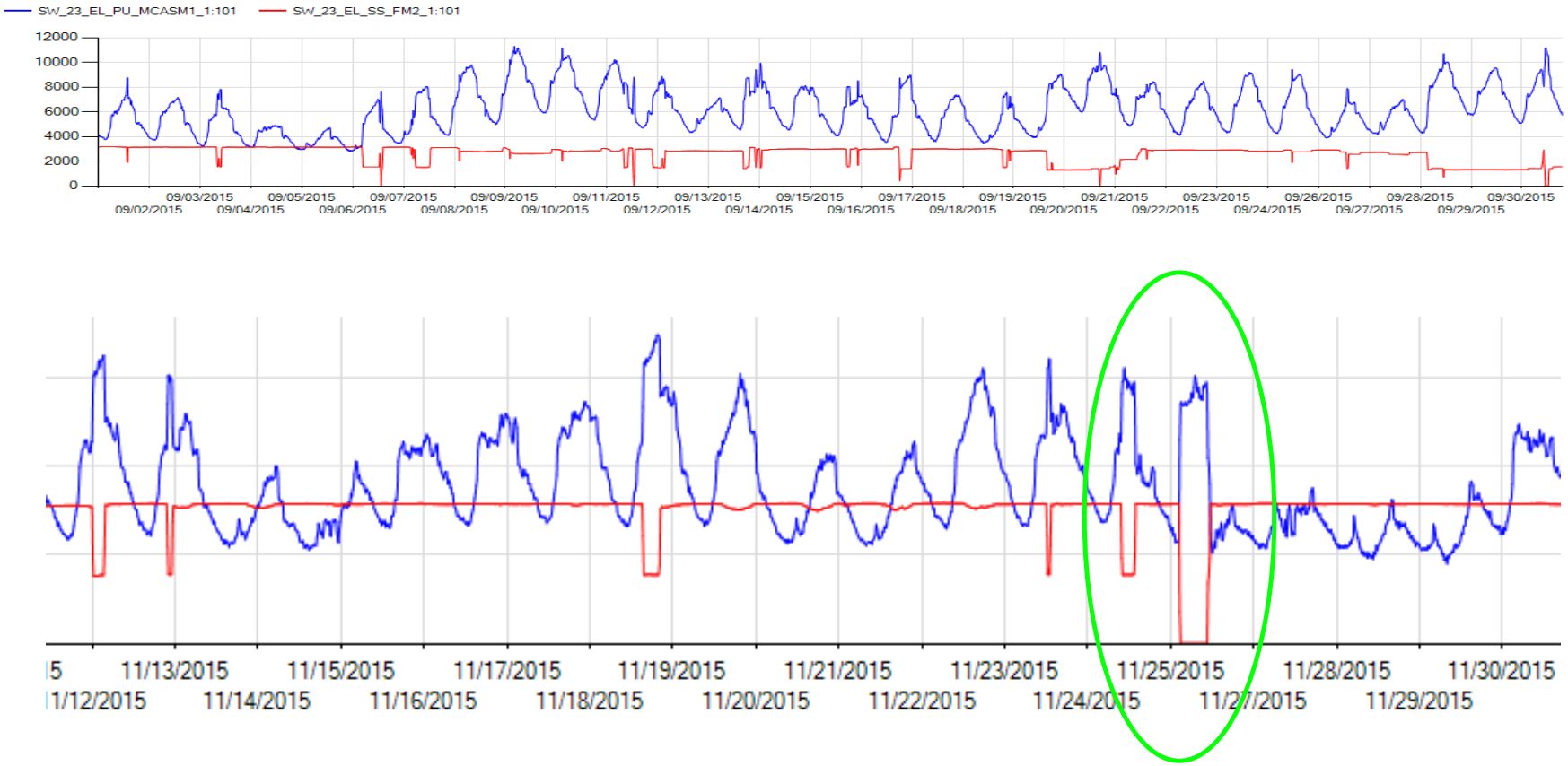


MCAS Miramar Load Profile

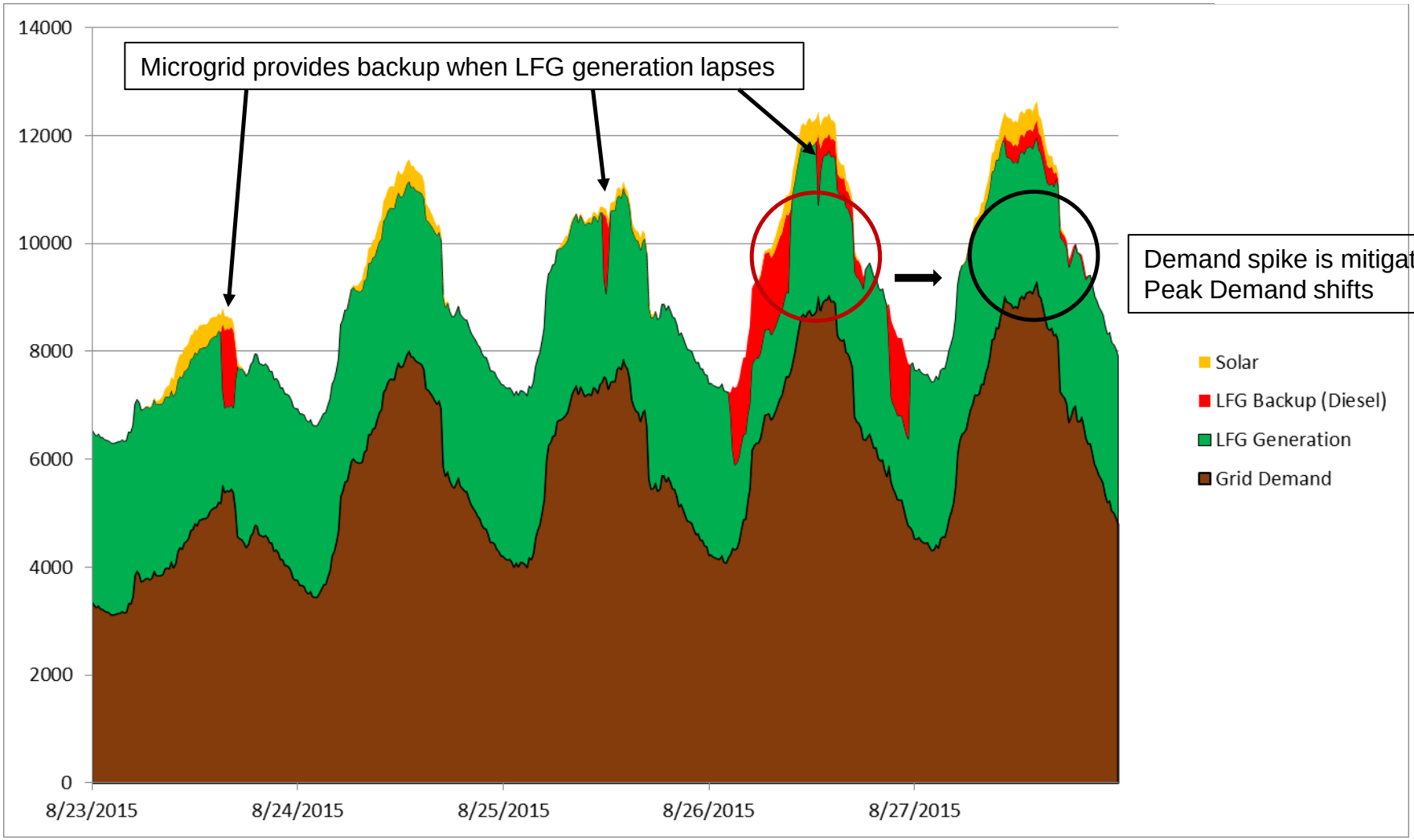


Landfill Gas Power Reliability

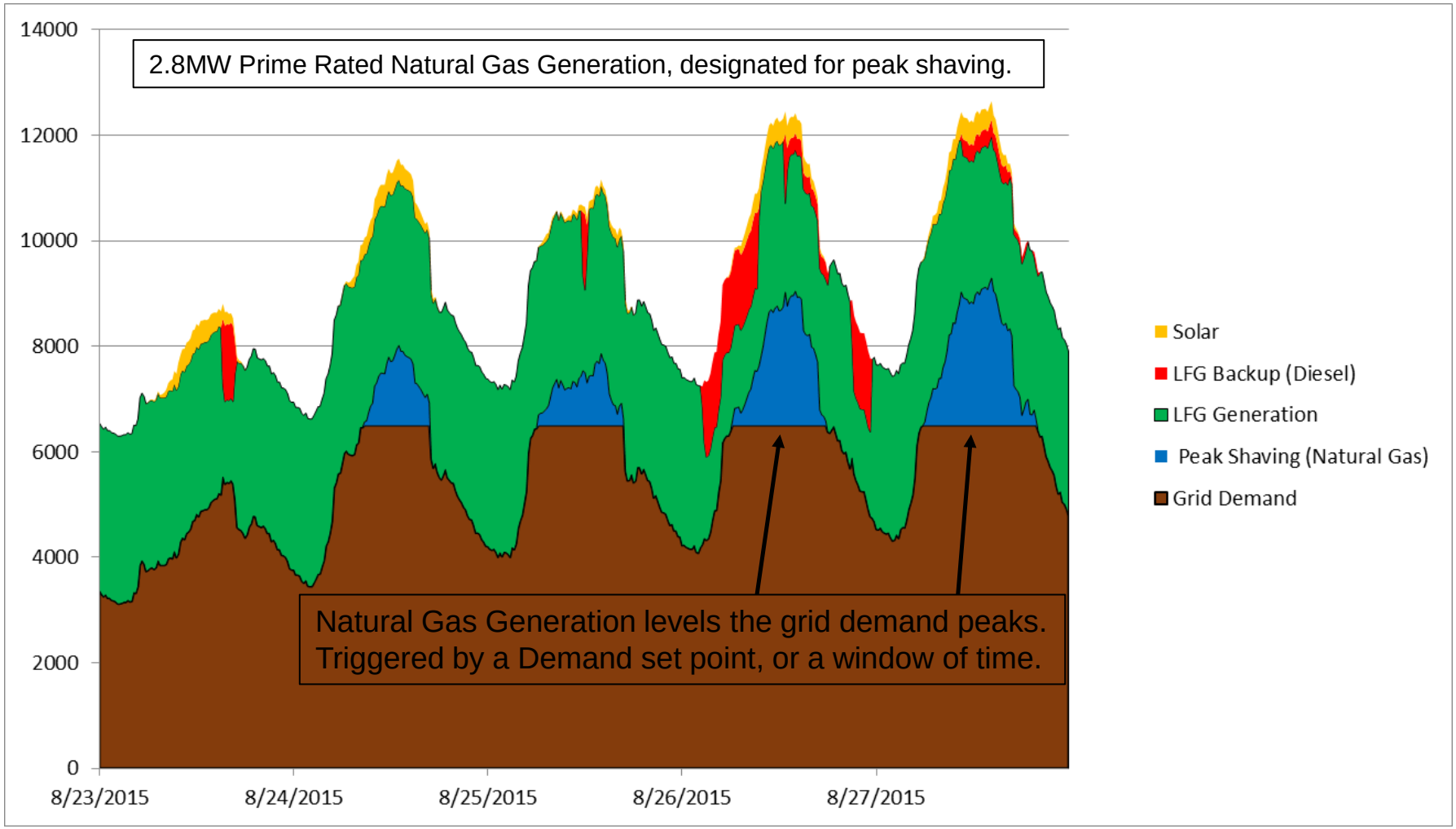
Landfill Power — Installation Load from SDG&E



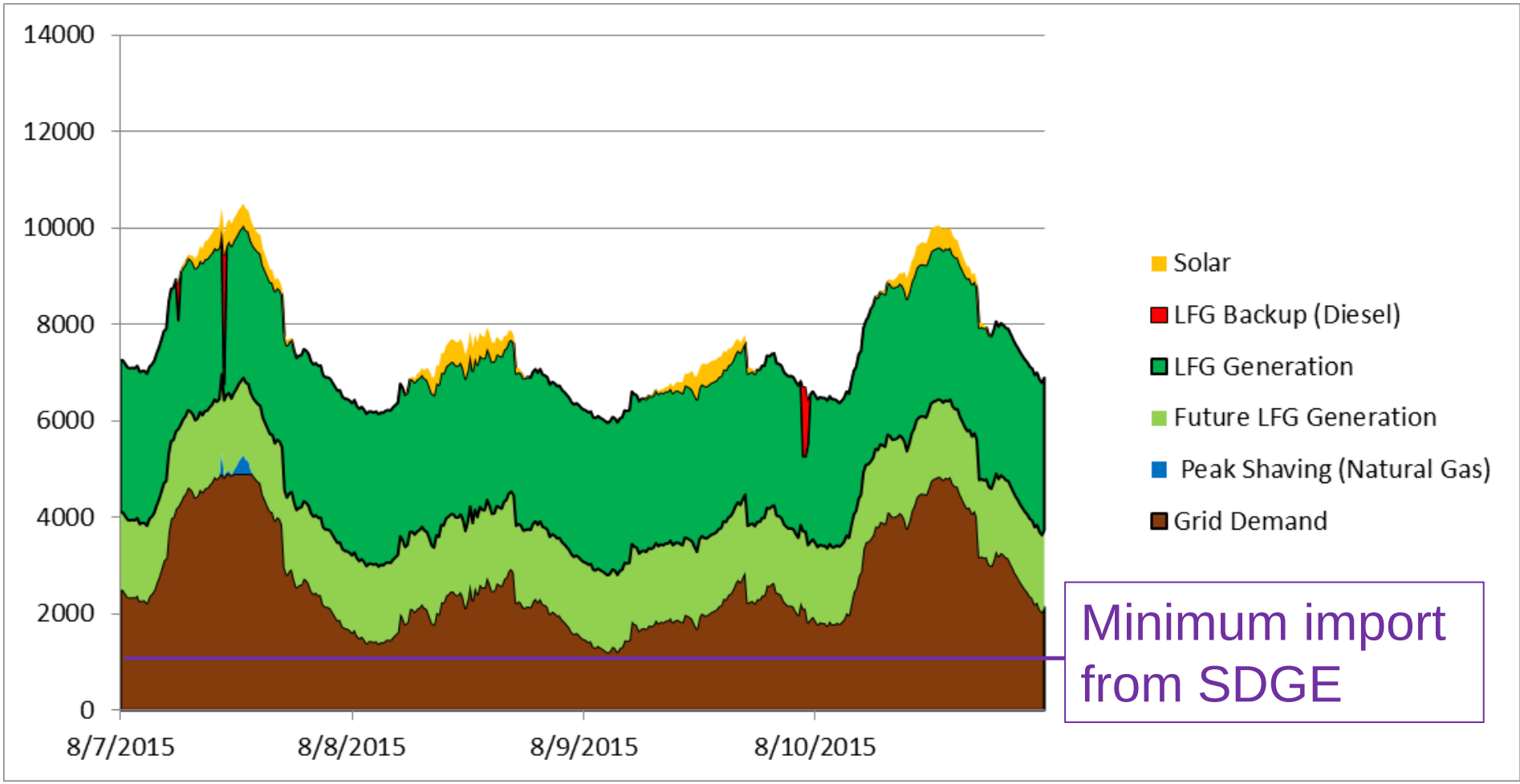
Load Profile with LFG Backup



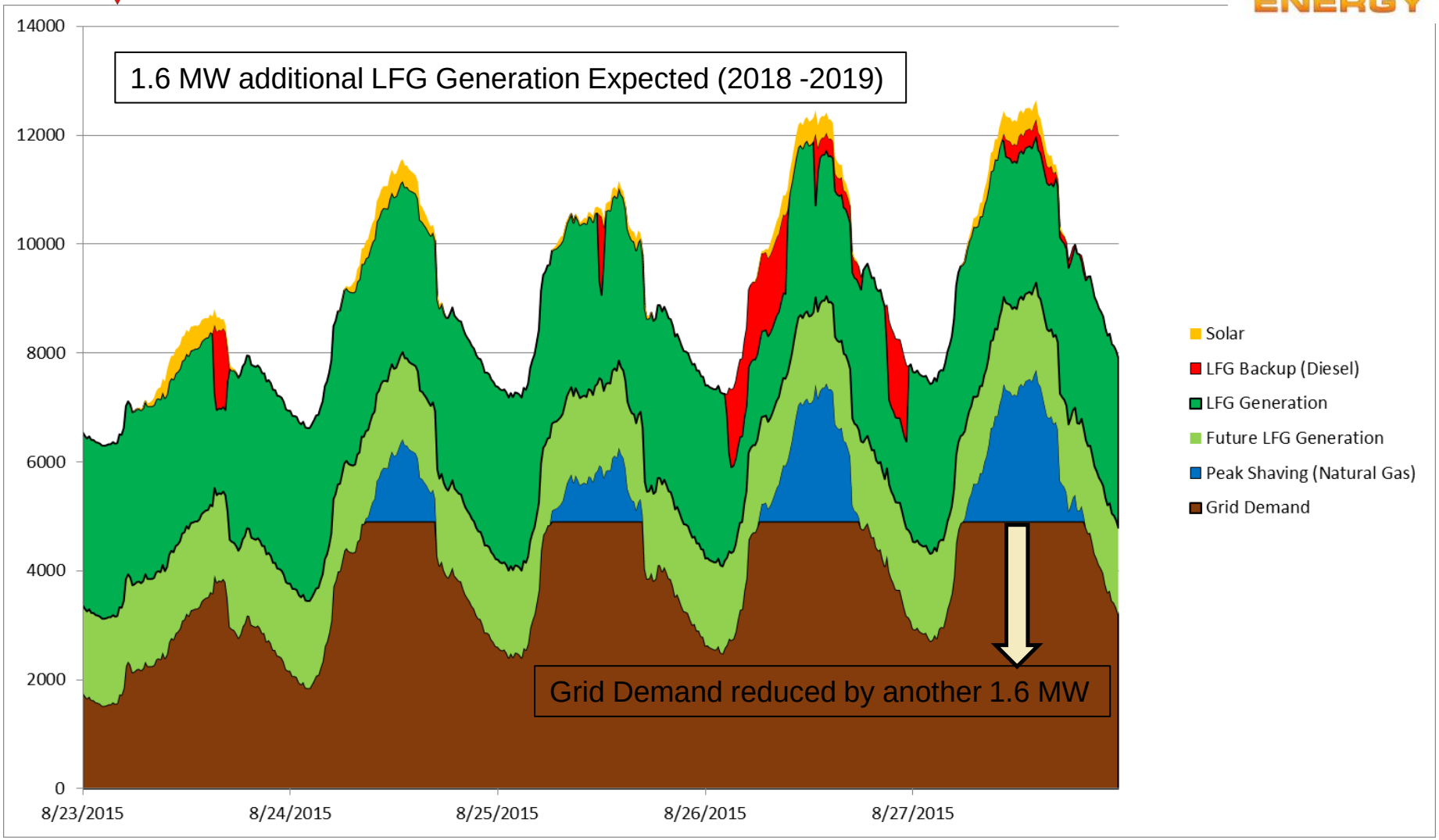
Microgrid Peak Shaving & LFG Backup



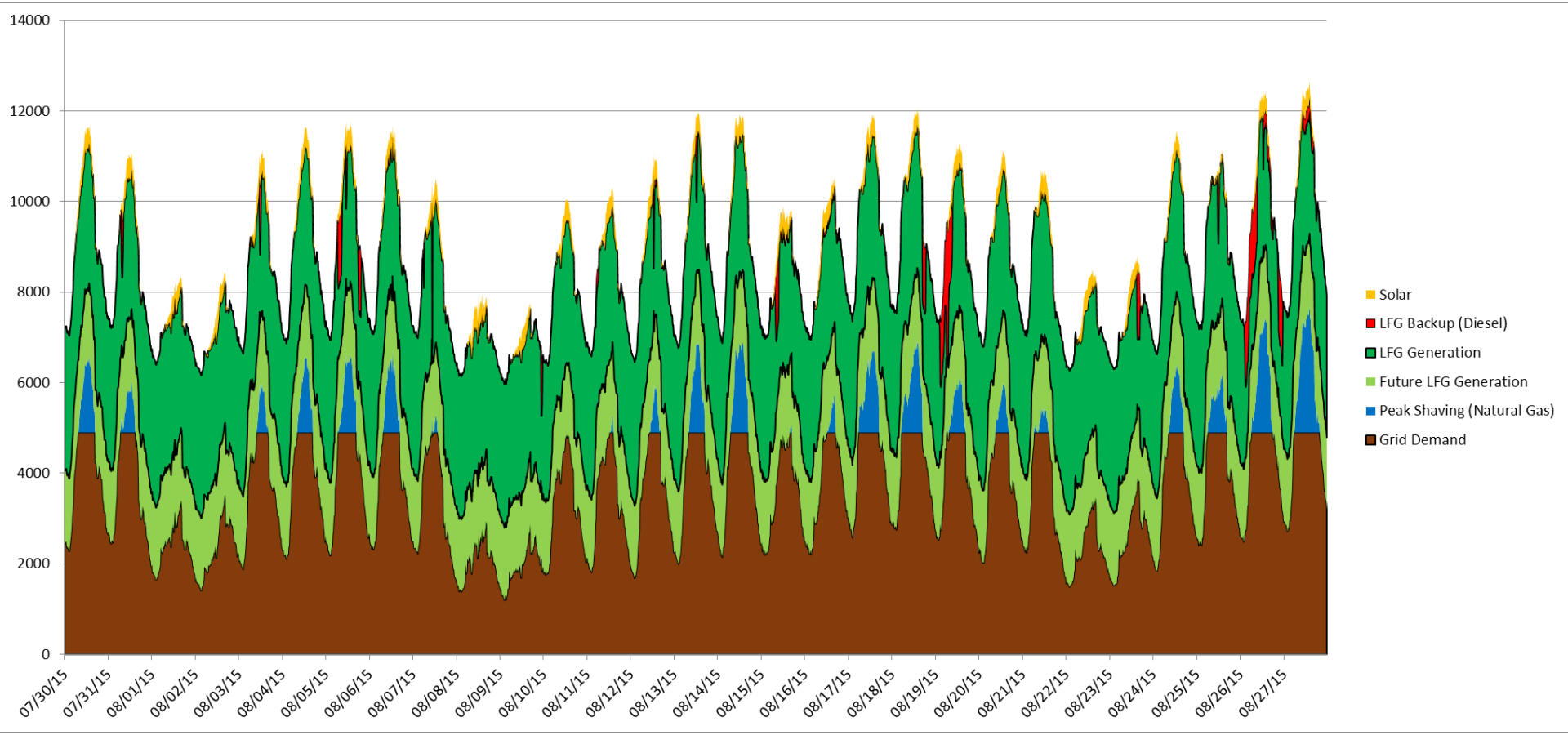
Microgrid Operation during Low Demand



Microgrid with LFG Expansion



Monthly Microgrid Operations



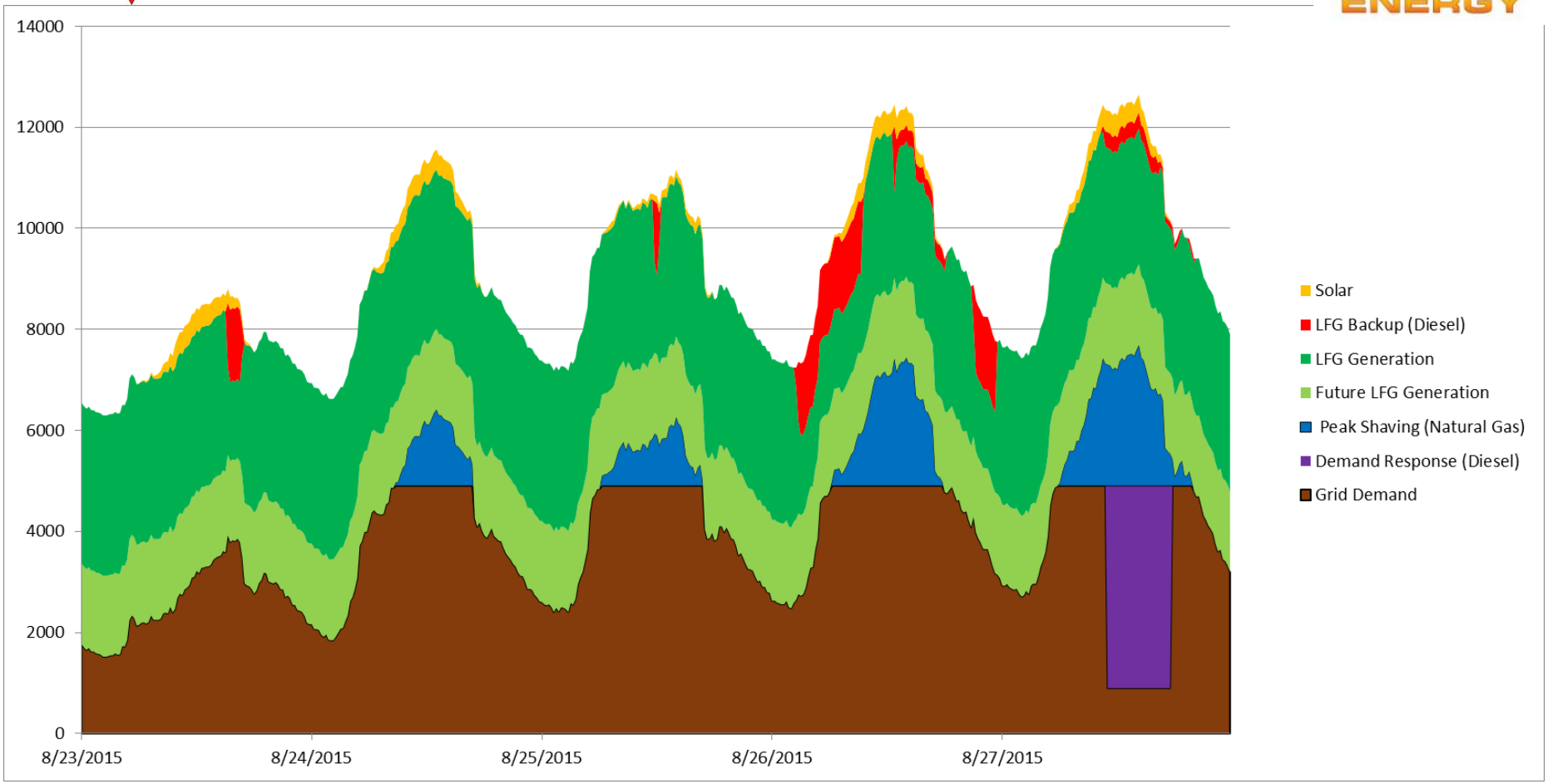
Demand Response

"Expand Microgrid functionality for best return as opposed to just islanding" – ASN McGinn

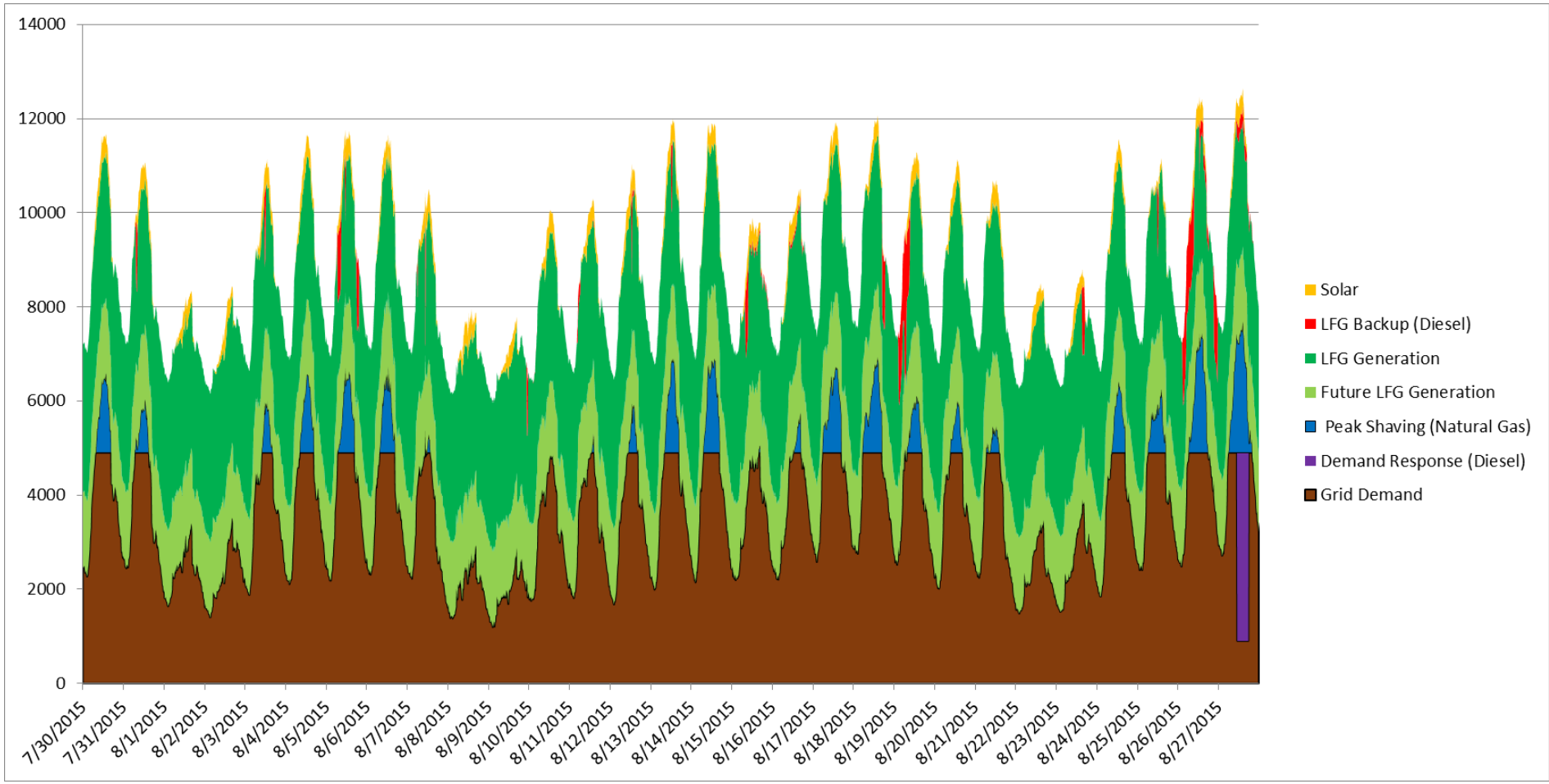
Microgrid needs to support of the "macro-grid"… - Byron Washom

CPUC: Emergency Generation Limitations:
"Participating customers are prohibited from achieving energy reductions by operating backup or onsite standby generation"

Microgrid Operation with Demand Respons Event



Monthly Operation with Demand Response Event



Renewable Portfolio

SDG&E

Renewable: 24%
- o Biomass & waste: 3.0%
- o Geothermal: 2.0%
- o Solar: 4.0%
- o Wind: 15.0%

Non-renewable:
- Coal: 3.0%
- Natural gas: 67.0%

In 2013

MCAS Miramar

Renewable: 55%

PV: 5%

LFG: 50%

75% in 2019

Non-Renewable: 45%

20% in 2019!!!

Hours and Savings

Generation Type	Permitted Hours (hrs/yr)	Estimated Hours of Operation (hrs/yr)	Potential Cost Savings
BACT Natural Gas Engines	5000	2100	~ $300K
Tier 4 Diesel Engines – Landfill Back up	1500	950	~ $250K
Tier 4 Diesel Engines – Demand Response		~50	~ $200K-$400K
Additional Landfill Power	8736	7786	~ $750K

Total Microgrid Potential Savings = $950K /year

Take Away

- MCAS Miramar is currently about 50% renewable electric and is targeting to be 75% by 2019
- Energy Resiliency assets whose number one function is back up power in microgrid island mode will be multi-purposed for macro-grid support and cost savings in grid connected mode
  - BACT Natural gas engines used for peak shaving
  - Tier 4 Diesel engines used to back up LFG Renewable Power and possibly Demand Response
- Microgrids may be highly renewable, however a certain amount of conventional generation may be required for reliability and surety
- Distributed Energy Resources installed by customers can provide redundancy for the customer as well as the utility
- Is this scenario part of the business case for microgrids?

Thank you

Contact Info

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